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DESIGNING INFORMATION MODEL FOR THE PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS): A CASE STUDY

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ABSTRACT

As of today, many construction participants have been less eager to effectively manage and use information of construction projects. By effectively managing project information, the participants will not only be able to make precise analysis and decision-making, but they can also record the information for future reference during claims and making estimates on similar projects. Currently, the efforts to apply information technology (IT) to project management process are remarkably increasing. Success or failure of PMIS application is entirely dependent upon the efficiency of its information and process model based on it. These are important factors to consider for a useful system. By analyzing the previous information models and current work process, entities organizing model are identified and the relationships are designed. In order to confirm the possibility of its application, PMIS prototype is developed in this research.

KEYWORDS

PMIS, Project Management Information System, Information Model

1. INTRODUCTION

Traditionally, the construction industry is featured by large numbers of participating companies collaborating for relatively short project life-spans, a lack of control over the location, low levels of management support, and fragmentation within the industry (Russel and Froese 1997). Participants in construction projects, especially those involved in mega-sized projects, rely much on various construction information. Not only is such information necessary to describe the required work at certain phase of the project, but it can also be of help during analyzing and decision-making process. Furthermore, it can be useful when passing it on to other participants, recording for future reference during claims and making estimates on similar projects in the future (Tenah 1981, 1984, and 1986). It is therefore vital for participants in large-scale projects to manage and operate construction information with efficiency in order to lead the project into success.

Rather than relying on sheets of paper to classify and control information, it is more efficient to make use of computers to effectively handle and process in large quantities all relevant project information with ease, and throughout the life of the construction project. When appropriately established, the paperless information control system can make labor-consuming calculation and data managing works very easy and highly productive.
However, unlike other industries, the construction industry is still deeply rooted in traditional methods and customs

of handling works, and is slower at adopting changes. Therefore many obstacles have to be overcome before the computer-based information control system can take full effect. Some of these obstacles are as follows :

- Lower percentage of computer skilled workers within the industry than others.
- Higher requirement and difficulty in standardization of data information and work procedure due to complexity and diversity of project information.
- Lack of collective reciprocity among project information due to uniqueness of each construction work and difference in information breakdown structure.

In order to overcome these obstacles, the information system such as PMIS should be designed as they wants and works. For the overall picture of the system, information or process modeling is required from the initial stage.

2. RESEARCH METHODOLOGY

The scope of the project management information system to be developed is proposed in this research, by taking the present network and integration technology into consideration. Also, various surveys and interviews were carried out at job sites as well as in offices in order to reflect practical needs of workers. 15 construction experts working in 3 different sites, and having more than 10 years of field experience, have responded to the interviews : among them included construction managers, inspectors and field workers. The interviews helped in narrowing project works that required computerization and would be the most beneficiary of such system. Priority for development was then given according to the importance of work.

The forms, documents and procedure manuals that were used at the field sites were collected for analysis. From the procedure manuals, the overall work flow and its detailed processes were derived, while the documents and logs indicated which work items are valuable and worth to be considered in the system. The process and work data are then modeled for the design of the system's database.

After designing the process and data model, a prototype system was developed and was made accessible, regardless of time and location, by linking it to the web system. This web-based prototype system was then applied to a case project for system review. Many discussions with the actual users of the system, including field workers and office operators, were held in order to gather any potential problems that arose during operation.

3. RELATED ENDEAVORS FOR PMIS

3.1 Standard for Construction Information

Needless to say that for more effective management of project information system, standard for construction information is required. But setting standards for construction information code is critical and involves many obstacles, compared to other industries.

IAI(International Alliance for Interoperability) has suggested IFC(Industry Foundation Class) as a standard class model. North America and Europe have their unique standard of classification such as MASTER FORMAT and CI/SfB, other countries still lack any system of such kind. In Korea, KICT(Korea Institute of Construction Technology) has taken steps to develop a standard for classifying construction information, and it is nearly a hybrid structure of MASTER FORMAT and CI/SfB. Although its practicability and efficiency still needs time to be proven, there are still many works to be done in order for the standard to be integrated.

3.2 Construction Management Domain in IFC (Industry Foundation Class)

Several IFC projects undertaken by different regional domain committees focus on project management related aspects of the IFCs. These include the North American Project Management Committee's Cost Estimating project (Project ES-1.8th for IFC Release 2.0) (Cole et al. 1998a) and Construction Scheduling Project (PM-1 for IFC Release 3.0) (Grobler. et al. 1998). The PM-1 project includes not only the construction scheduling process, but also the process of initializing a schedule from a cost estimate. Processes to examine extensive estimate and schedule integration, and generic scheduling, have been deferred to future projects, yet all of these efforts are being developed with an eye towards integration and a uniform approach to information.

3.3 Performance Measurement using EVM (Earned Value Management)

Since July 2000, Korean building regulations required the use of EVM methodology for public construction projects over 45,000,000 US dollars. Even for projects where EVM methodology is not compulsory, it is important to measure and evaluate their performances by taking schedule and cost information as an integrated whole.

Since most of the public construction projects in Korea have been marked by lump sum price instead of cost-plus-fee, and project management is characterized by and based on a cost item rather than an activity, there is a problem to directly applying EVM methodology for projects in Korea. But in light of building codes requiring more and more activity-based management system, this research has taken the opportunity to measure the performance of construction projects by applying an activity-based management system.

3.4 Commercial Project Management Systems

Many web-based project management systems have been developed and commercialized since 1998 on the Internet. The systems usually provide the following services :

- Sharing of information among remote project participants and collaborating on drawing documents.
- Communications through on-line messaging services.
- Control of project drawings by accumulating historic information and management of change requests using redline techniques.

These systems are mainly aimed at the general features of managing a construction project and provide limited services for specific projects that involve complexity. In the end, they cannot provide key functions that meet the needs of construction field workers.

4. DEFINING THE SCOPE OF PMIS

Construction management system is not prevalently applied to construction projects. Especially Korean construction industry has adhered to traditional organization system where inspectors play a limited construction manager's role in behalf of the owner. Because of the loss from lack of effective management, some of the construction industries are trying to introduce PMIS for their job sites. To get the most effectiveness from the system, initially the scope and the structure of PMIS have to be defined optimally.

The results of site surveys in this research can show that the most critical function with which PMIS should be equipped is schedule control function (32%), followed by overall project information (22%), cost control (14%) and provision for technical information (14%), in order of importance.

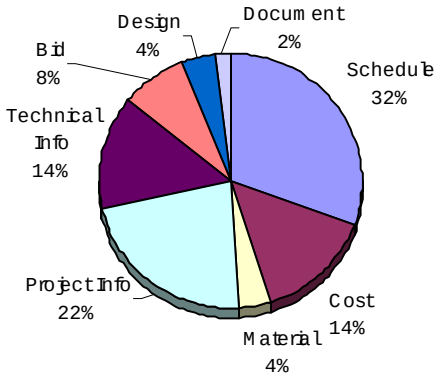

Figure 1: Important Functions in PMIS

TABLE 1: Survey Results : Important Factors of Project Management Functions

Knowledge Area	Procedure	Owner	Architect	Contractor	CM
Project Integration Management	Project Plan Development	30	15	18	27
	Project Plan Execution	29	13	19	26
	Overall Change Control	29	16	22	28
Time Management	Establishing WBS	22	13	27	29
	Activity Definition	19	13	29	29
	Activity Sequencing	16	12	29	27
	Activity Duration Estimating	18	12	30	28
	Schedule Development	18	12	30	27
Cost Management	Schedule Control	17	12	30	28
	Resource Planning	24	13	28	25
	Cost Estimating	28	13	25	28
	Cost Budgeting	29	12	28	26
Quality Management	Cost Control	24	11	28	26
	Quality Planning	18	12	29	27
	Quality Assurance	16	13	29	27
Human Resource Management	Quality Control	18	12	30	27
	Organizational Planning	19	8	28	27
	Staff Acquisition	17	8	28	27
Communications Management	Team Development	19	9	29	28
	Communication Planning	22	18	24	27
	Information Distribution	21	18	20	23
	Performance Reporting	24	16	24	28
Risk Management	Administrative Closure	28	17	27	29
	Risk Identification	22	12	29	29
	Risk Quantification	21	13	28	29
	Risk Response Development	19	12	26	28
Contract/Procurement Management	Risk Response Control	19	12	25	23
	Procurement Planning	22	10	26	27
	Solicitation Planning	27	10	22	24
	Solicitation	26	11	22	23
	Source Selection	29	16	22	23
	Contract Administration	27	13	27	28
	Contract Close-out	25	13	27	28

The project management functions categorized in this research are based on “PMBOK” of Project Management Institute (PMI). Analysis of results show that the contractor and CMr/inspector are closely related to each other when it comes to schedule and cost control, while the owner and contractor are mainly interested in the project cost. Though the importance factor was rated average, all project participants stressed the importance for communications.

5. MODELING AND IMPLEMENTATION OF PMIS

5.1 Structure of the PMIS

Following figure is the structure of PMIS which is designed based on the results from the survey and other researches.

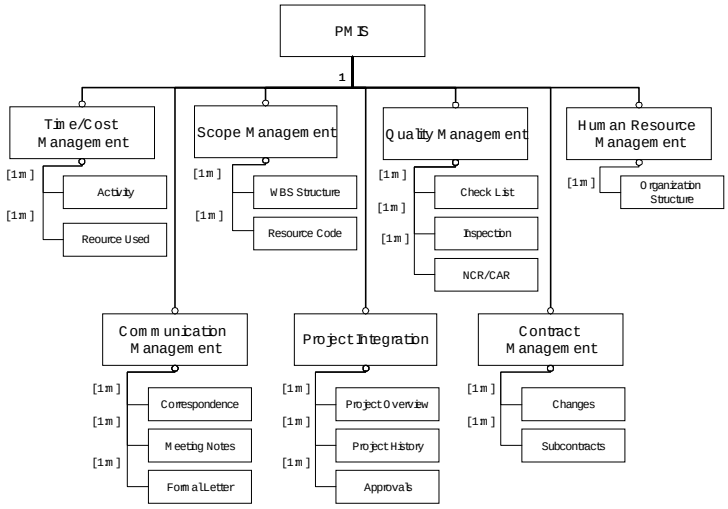

Figure 2: Organization of the PMIS Prototype System

For the complete PMIS system, process modeling which defines the flow of the system and information modeling which defines the data structure of the system are needed. Process model can be defined using IDEF0 which is ISO's standard process modeling tool. Entity relationship diagram(ERD) or EXPRESS-G diagram is used for the information modeling process. Following figure is the example of information model using EXPRESS-G with Time/Cost management function.

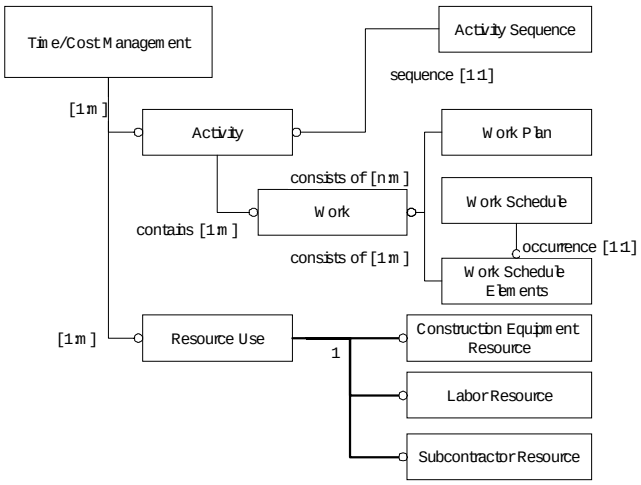

Figure 3: Example of IFC Scheduling Data Model

5.2 Development of Prototype System

A prototype system is developed using the latest technology in web, Relational Database and others, which are prevalently used nowadays. Though one may expect that interface technology, inside data processing and graphic visualization of information will keep on enhancing, the prototype developed in this research applied a text-based data so that it can later be used in a more advanced technical environment.

Scheduling data are extracted from the scheduling program. In this research, P3 (Primavera Project Planner) scheduling package is used. Microsoft Windows NT OS, SQL Server 7, and IIS(Internet Information Server) are chosen to build the server for the prototype system. Program languages such as Java, VBScript(ASP), and JavaScript are used, in a client environment with Internet Explorer 4.0 and higher.

Figure 4: Prototype System Example for the Scheduling Data

6. CONCLUSIONS

Many companies nowadays are putting efforts to build their own construction management information system, but due to difference in work scope and activities, each system varies from each other at some extent. With such background, this research is aimed at developing an information management system that can be directly applied to the Korean construction industry, with inspectors having the role of construction managers.

The design of the system is achieved by carefully reviewing and analyzing the needs of participants through job site interviews and surveys. Also, work procedures and all of the technical documents are collected from the offices as well as job sites to be reflected for defining the scope of the system to be developed. Furthermore, in order to standardize construction information, on-going standardization efforts from public and private sectors are examined for application.

A prototype system is developed, by considering the survey results carried out during this research. The prototype is then applied to a case project in order to detect any potential problems and present their solutions. The standard information system presented in this research can be a base for the on-going construction CALS project carried out by the Korean Ministry of Construction.

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